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Referendum, Response and Consequences for Sudan

The Game between Juba and Khartoum

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Abstract

This paper presents a game theory model of the strategic interaction between Khartoum and Juba leading up to the referendum on Sudan's partition in 2011. The findings show that excessive militarization and brinksmanship is a rational response for both actors, neither of which can credibly commit to lower levels of military spending under the current status quo. This militarization is often at the expense of health and education expenditures, suggesting that the opportunity cost of militarization is foregone economic development. These credibility issues might be resolved by democratization, increased transparency, reduction of information asymmetries, and efforts to promote economic and political cooperation. The paper explores these devices, demonstrating how they can contribute to Pareto preferred outcomes in equilibrium. The authors characterize the military expenditure associated with the commitment problem experienced by both sides, estimate its costs from data for Sudan, and identify the opportunity cost of foregone development implied by continued, excessive, and unsustainable militarization.

This paper—a product of the Growth and the Macroeconomics Team, Development Research Group—is part of a larger effort in the department to analyze the development impact of conflicts and military expenditure. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The authors may be contacted at ielbadawi@worldbank.org, gmilante@worldbank.org or cp2417@columbia.edu.

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Non-Technical Executive summary

This paper presents a simple game-theoretic framework to analyze the potential impact on peace in Sudan of the 2011 self-determination referendum to be made by the people of the south as envisaged by the Comprehensive Peace Agreement (CPA). We highlight and discuss several policy implications for the key political actors in the Sudan, most notably the two ruling parties, the National Congress Party (NCP) and the Sudanese Peoples Liberation Movement (SPLM), as well as the international community.

In our model, the South (Juba) makes the first move by deciding whether to pursue independence or remain part of a unified Sudan, on the basis of its expectation of the North's (Khartoum) response. We assume that both sides prefer the status quo (peace with unity) to the re-ignition of conflict. This fundamental assumption is justified by the fact that both sides had signed the CPA and subsequently became leading partners in the government, reflecting their preference for peace. Under these assumptions, Juba does not opt for partition if Khartoum can credibly threaten war. It is important to keep in mind throughout this paper that a threat of conflict in this model need not be explicit or realized conflict, and therefore, may not manifest as an outright violation of the peace agreement. Instead, these threats could be through a variety of signaling devices, including increased military expenditure. Khartoum's response is determined by a cost-benefit calculation: if the expected benefits from responding with war to Juba's bid for independence are higher than the expected costs, Khartoum will send a signal that it might resort to arms. Oil fields in Unity State and Upper Nile, and may be Abyei as well, which might otherwise go to the South under partition are identified here as the spoils of war. Almost all of these oil fields happen to be close to the North-South borders (see the map in Appendix Figure 1). If Khartoum can expect to secure a threshold percentage of the oil fields through conflict, then they would signal that they might prefer war to a peaceful partition. However, should war happen, and we are not suggesting that it will, military success requires that Khartoum incur a cost by spending in the military. Moreover, should it choose to mount a military response, Khartoum will also have to incur an additional cost proportional to Juba's military expenditure. On the other hand, Juba's military expenditure could be thought of as a deterrent to the hypothetical military response by Khartoum in defense of self-determination. Therefore, both Khartoum and Juba have incentives for very high levels of military expenditure to reach their preferred outcomes. While this military expenditure may be a perfectly rational response for both actors, this militarization is not made in a vacuum and comes from the same budgets that provides public goods and service delivery, so military spending is often made at the expense of development opportunities that are being foregone. Therefore anything that can be done to increase the commitment of both actors toward peace can be framed as a development activity.

In the basic specification of our model, we assume perfect information and therefore rule out the possibility that Juba pursue independence under the incorrect expectation that Khartoum would acquiesce, thus inadvertently provoking war. In this context, both sides have incentives to manipulate the expected costs and benefits of a hypothetical military confrontation, for example by increasing military spending. Thus, high military

expenditures by Juba could reduce Khartoum's benefits from war and therefore reduce its incentives to violently retaliate in case of partition. At the same time, Khartoum has an incentive to invest in the military so as to improve its potential benefits from a hypothetical war and thus discourage Juba's bid for independence.

In the second specification of the model, we relax the assumption about perfect information, allowing for uncertainty, on Juba's part, about Khartoum's expected gains from war and consequently about its response to a pro-independence vote. In this situation Khartoum has an interest in signaling a high payoff associated with war, thus discouraging Juba from pursuing partition. However, Khartoum's signals would lack credibility because Juba knows that its adversary would have an incentive to misrepresent its incentive structure to discourage partition. In this specification of our model there is a risk of inadvertent war. An even more dire scenario is characterized by a combination of imperfect information and significantly increased military expenditures by both sides, which may move both actors beyond their preference for peace. In this case an additional risk of war emerges; where beside pushing both sides to misallocate scarce economic resources, an arms race between Khartoum and Juba would risk generating a security dilemma, in which each actor sees the other's efforts to arm as potentially aggressive and may be tempted to launch a preventive attack for fear of being attacked in a moment of relative weakness.

The moral of the model at this juncture is that both sides are likely to engage in an arm race not because they prefer war to the status quo, rather because each side uses military expenditure as a signaling device. Khartoum would like to deter Juba from casting the partition vote, while Juba endeavors to make a military response by Khartoum as costly as possible. While tractability requires a focus on a quantitative metric like military expenditure, the predictions of the model can be generalized to include other means that increase costs, such as mobilizing allies within the other side's regional powerbase. Indeed, both the NCP and the SPLM have exploited this option in the past during the civil war. For example, the NCP has trained, funded and armed tribal Southern Sudanese militias opposed to the SPLM, while the latter attempted to bring the war to the north through recruitment of fighters and building of military and political alliances with rebellious northern groups in Darfur and Eastern Sudan.

Because development is the opportunity cost of this militarization by both sides, the international community could have a positive role to play here and has clear incentives for intervention. Encouraging commitment to the peace process for both sides can decrease incentives for militarization and contribute to development. The international community could encourage this commitment by providing support to the completion of the CPA-mandated agenda, such as the demarcation of North-South borders; the census; the resolution of the disputed Abyei region; and other technical issues related to the general elections of 2009. We demonstrate how these basic steps can contribute to credible commitments by both actors. Moreover, urging more transparency on both sides' military expenditures can reduce information asymmetries and thus the risk of war by miscalculation.

In the third variant of the model, we assess how the risk of renewed civil war would be affected by a process of democratization of Sudanese politics (including the 2009 elections). Democratization is shown in the model to provide a useful commitment device and to resolve some of the credibility issues that are currently contributing to excessive militarization by both sides, resulting in the possibility of unwanted and unintended conflict. The reduction in the equilibrium level of military expenditure associated with democratization would free resources to be spent on development, represented by the MDGs. Our simulations suggest that the payoff for both peace and development in the Sudan could be very large. First, large savings can be achieved by even modest reductions in military expenditures; and, second, the returns of expenditure on the social sector is likely to generate significant progress in terms of the MDGs targets, given the very low standards of human development in Sudan, especially in the South. Democratization is also likely to have much more significant impact beyond its positive influence associated with reduced military expenditure. A genuine democratic transformation might actually make unity attractive to Southern Sudanese; and even if the latter opted for partition, the two emerging democracies are likely to assign a higher value to economic interdependence and cooperation than any payoffs that might be reaped by conflicts and war. Moreover, democratization may be a precondition for a range of other initiatives that have been proposed for enhancing economic interdependence and cooperation.

Finally, we explore a range of initiatives for peaceful coexistence and cooperation and demonstrate how these extensions alter the payoffs for both sides. These include enhanced economic inter-dependence through the oil sector, trade, accommodations for nomadic northern Sudanese tribes and Southern Sudanese living in the North; a cooperative Confederal option; and a neutral Abyei zone as an investment in peace.

The fundamental implication of our model is that increasing, unsustainable and dangerous militarization is a rational response to the status quo and will continue so long as there is no progress toward democratization. Genuine democratic transformation may be a necessary condition for credible commitments from both actors even if it is only for the pragmatic goal of preventing conflict and war between the two emerging Sudanese states. Likewise, following on signals from the SPLM, it appears that there is little chance for the more ambitious goal of a united Sudan without a genuine democratic transformation leading to a more democratic federalized political order entailing substantial realignments of political and economic powers towards the South and other marginalized regions of Sudan. This assessment has far reaching implications for the international community's approach to the peace processes in Sudan, be they north-south or Darfur. We contend that the international community should promote a wider process of political dialogue in the country as increased political enfranchisement may be the only way to build missing credibility in the commitment to peace from both Khartoum and Juba

1. Introduction

In 2011, the people of Southern Sudan will participate in a popular referendum on independence, as agreed to in the Comprehensive Peace Agreement (CPA) of 2005, ending Africa's longest civil war[1]. The CPA was signed by the (then) Government of Sudan, represented by the National Congress Party (NCP), and the Sudan's Peoples Liberation Movement/Army (SPLM/A), the rebel movement fighting the government since 1983. The *de facto* one-party state rule of the NCP following the National Islamic Front's coup of June 1989[2] represents the interest of the military-security establishment but also espouses an Islamist pan-Arab agenda. The SPLM is largely, but not exclusively, based on the dominantly animist and Christian non-Arab Southern Sudan; it has, not surprisingly, emphasized the African heritage of Sudan and called for a secular democratic "new Sudan".

Ushering an end to a long and bloody civil war involving two ambitious political organizations with two radically different visions for the country, the birth of the CPA has been a difficult process, resulting in a complex and elaborate agreement[3]. It contains protocols covering the provisions for the referendum; security arrangements; wealth and power sharing; resolution of conflicts in Southern Kordofan and Blue Nile States- two

[1] The Sudanese civil war had started in 1955, even before the full independence of the country one year later, and was interrupted by a ten year peace following the Addis Ababa Peace Agreement in 1972 between the military government of General Numeri and the South Sudan Ana Nya Rebel movement, which granted South Sudan regional autonomy. However, this peace agreement collapsed in 1983, ushering the second phase of the insurgency led by the Sudan's Peoples Liberation Movement/Army (SPLM/A); (for further review of the Sudanese civil war, see, for example, Ali, Elbadawi and El-Batahani (2005) and references cited therein).

[2] The National Islamic Front is a political party formed by the "Islamic Movement", led by Hassan Al-Turabi, in 1985 prior to the national elections that led to the formation of the third Sudanese democratic government (1986-89).

[3] A current map of Sudan, north/south states, the proposed borders and boundaries associated with the referendum and the disputed area of Abyei is shown in Appendix Figure 1.

transitional northern regions where the SPLM has military presence and a measure of political influence; and resolving the status of Abyei, a disputed oil-rich region between North and South, which had often times witnessed violent conflicts between nomadic Northern and Southern tribes over water and grazing areas[4]. The CPA has so far led, among other accomplishments, to the appointment of a government of National Unity (GNU) dominated by the NCP (52%) and the SPLM (28%); the establishment of a government of Southern Sudan (GOSS), dominated by the SPLM, with authority in the South; and the implementation of an oil revenue sharing formula, which applies to the oil produced in the South. This formula allocates 2% of the net revenues from this oil to Southern producing states, leaving the remainder 98% to be equally shared by the GNU and the GOSS.

However, and despite the elaborate implementation modalities detailed in various protocols annexed to the CPA, little or no progress has been made on key areas, such as demarcation of the borders between North and South, a population census and the repatriation of the internally displaced Southern Sudanese[5]. Lack of progress on these areas casts doubts on the prospects for holding the mid-term general election in 2009, a critical step in the democratic transition, judged to be necessary for providing popular legitimacy to the CPA and for promoting the option of unity for Southern Sudanese in the referendum of 2011- so called "making unity attractive"[6]. Moreover, the NCP and the

[4] As this working paper is being revised a tentative agreement (the "Abyei Roadmap") on Abyei has been signed (June 8, 2008) – which includes provisions for replacing military forces in the area with fresh units that do not have histories of conflict in the region, increased access for UNMIS, transparent civil administration of the region and return of displaced persons.

[5] See various CPA Monitor reports by the UN Mission in Sudan (UNMIS) at www.unmis.org. Also see Ali (2007) for an analysis of the implementation issues regarding the wealth-sharing component of the CPA.

[6] The making "unity attractive" was a phrase coined by the late SPLM leader Dr. John Garang, which suggests that Southern Sudanese would be persuaded to cast the unity vote, should the Northern Sudanese demonstrate commitment to the ideals of the "new Sudan", espoused by the SPLM and its late leader.

SPLM have been locked in bitter disputes about demarcation of the North-South borders, especially near oil fields; the transparency of operations in the oil sector[7]; the population census; redeployment of forces; and the status of Abyei[8]. These issues threaten to be the thorniest challenges facing the two partners (ICG, 2008). These difficulties, in addition to differences between the two partners regarding resolving the conflict in Darfur[9] were cited among the main factors behind the decision by the SPLM in October 2007 to suspend participation in the GNU. However, with active mediation by the US and other external actors, just two months later the two parties were able to resolve their disputes and return to the GNU, with the exception of the Abyei issue, which will be directly addressed by the Presidency[10]. Consequently the SPLM has decided to resume its participation in the GNU. Nonetheless, this crisis demonstrates the precarious nature of the Sudanese peace process and the importance of long-term strategic planning to avoid similar crises in the future. While the CPA may have been instrumental in bringing about the end of the war, the recent crisis demonstrates that even the most exhaustive

[7] See Deng (2007a,b) for a perspective from GOSS and the SPLM.

[8] The CPA calls for the resolution of the Abyei problem in two steps. First, a boundary commission would determine the boundary of the district as well as whether it belongs to the north or south; and, second, the Southern Sudanese Dinka people of Abyei will decide in a referendum whether to be part of the south or the north. The boundary commission has ruled that the district belongs to the South and that the north-south border in that area should be adjusted accordingly. While the SPLM has accepted the committee's ruling and considers it binding, the NCP has rejected it, arguing that the Commission has surpassed its mandate. It is pertinent to note that what makes this matter so complicated is that the Messeriya, the main northern tribe who has lived side by side with the Dinka in Abyei for centuries, are adamantly opposed to the Commission's ruling. Moreover, almost all of the northern Sudanese political parties, though critical of the NCP monopoly over the CPA, also remain sympathetic to the Messerya's position. See footnote 4 for recent progress on Abyei.

9 While the NCP and the SPLM were heavily engaged in the negotiations leading to the CPA, a new insurgency erupted in 2003 in Darfur, the far western region of northern Sudan. This new civil war has touched off an international uproar due to the high number of civilian casualties; the vicious inter-communal violence associated with it and the massive scale of internally and externally displaced populations. It has been viewed with a lot of concern from the perspective of its corrosive effects on the CPA. (For analysis and assessment of the prospects for peaceful resolution of the Darfur conflict, see, for example, Ahmed and Elbadawi (2008).)

[10]The Presidency, as stipulated in the CPA, is composed of the President of the Republic, the First Vice President and the Vice President. Though the President and his VP come from the NCP, the First VP, nominated by the SPLM, enjoys a veto power on all key decisions. See footnote 4 for recent progress.

agreement may not be sufficient to maintain the peace, much less make "unity attractive"[11]. Instead, it appears that the referendum is more likely to lead to a vote for independence and a consequent partitioning of the country. Worse still, the Sudan may not even enjoy a "peaceful divorce", given the disputes over oil sites and the status of Abyei.

Therefore, the referendum will be a crucial political moment for the fragile country and, if freely and fairly executed, it will constitute an unprecedented move toward self-governance in the region, regardless of the outcome. In light of this momentous, impending occasion, this paper asks how the strategic actors in Sudan and the international community can best contribute to a welfare maximizing solution, using a simple game theoretic approach to capture the importance of timing and noise in the decision by the people of the South on partition and the response from the people of the North. The pivotal question is whether the NCP, the dominant partner in the Government of National Unity in Khartoum, can truly "make unity attractive" or will settle to simply "make an offer that cannot be refused".

This paper is not meant to be an exhaustive description of the extremely complicated issue of partition nor is the use of game theory intended to trivialize the very important dilemmas facing the country. Rather, it is hoped that the use of a simple model to represent North-South interactions will prompt thoughtful discussion on the importance of credible commitments for peace in Sudan. In the following sections we

[11] In a recent policy brief, John Prendergast and Roger Winter (2008) argue the burden of making "unity attractive" should rests overwhelmingly with the NCP, which should take a number of steps to ensure genuine power sharing and faithful implementation of the CPA; real resolution of the Darfur crisis; clear and lasting commitment to equality among all Sudanese citizens; free and fair elections; and prudent and equitable management of public money, especially from the oil, to create a tangible peace dividend for the whole of Sudan, including the South.

develop a simple model of the referendum issue and describe how it can be extended to accommodate issues such as military expenditure by both sides, incomplete information and a possible democratization process. We also discuss some instruments for enhancing economic and social interdependence between North and South that might increase the cost of conflicts for both sides and, hence, reduce the chances of a military response by Khartoum to a partition vote by Juba. These include consideration of confederation between North and South in lieu of outright partition to promote overall economic and political cooperation; turning Abyei into a neutral region governed by local tribes from both sides; enhancing economic interdependence through the oil sector, trade and transportation networks; and allowing the large Southern Sudanese community to remain in the North if they choose to do so, while providing continued access to the Arab nomadic tribes into the South during the summer. We conclude with a discussion of the policy implications for strategies of both actors and the international community.

2. A Game of Referendum and Response

In the most basic form of the game of referendum and response there are two actors by the names of Juba and Khartoum, representing the ruling elites of South and North Sudan, respectively[12]. By simplifying the decision-making processes of both groups of

[12] The popular legitimacy of both parties currently controlling these two sides, especially the NCP, is vigorously contested by other political forces. Were a bona fide fair and transparent general elections and a referendum to take place, the emerging leadership would have the legitimate claim to speak for the people in their respective regions. However, it is very likely that the game as represented here will be substantially influenced by the actions of the current partners well before the elections.

people into two actors, issues of collective action and conflicting interests within each group are assumed away for simplicity, admittedly at the expense of realism[13].

Juba acts first, deciding through the referendum on independence whether to secede or not. In Figure 1, these two strategies are shown in the light grey boxes as "Partition" or "Unity". If Juba chooses partition, Khartoum is given the chance to respond, with either war or peace. The strategies for Khartoum are represented by the grey boxes labeled "War" or "Peace". The payoffs for each actor are defined by the CPA and some assumptions on the costs and objectives of war. The following terms constitute the payoffs for the game:

A = Tax revenue to Khartoum based on CPA defined borders, $0<A$
B = Tax revenue to Juba based on CPA defined borders, $0<B$
R = Petroleum revenues, $0<R$
M_K, M_J = Military expenditures by Khartoum and Juba
δ = Share of petroleum revenues (land) that Khartoum can secure through war, positively related to military expenditures by Khartoum (M_K) and negatively related to military expenditures by Juba (M_J).
γM_J , γM_K = Cost of war for Khartoum and Juba, respectively (for simplicity, assumed to be directly proportional to the other actor's military expenditures).[14]

Currently, under the CPA in Sudan, the governments of the North and South receive tax revenues from their region and income from an oil-revenue sharing agreement[15]. Under

[13] In particular, this assumption does not account for the widely known division within the SPLM between the "southern nationalists", who tend to favor a southern-first strategy and concentrate on the 2011 referendum; and those who support the unity of the country under the vision of their founding late leader Dr. John Garang. While the first group is committed to self determination for the south leading to the partition of the country, the latter would like to challenge the NCP through forging of alliances with what they consider as the marginalized majority of the north. However, given the prevailing political conditions it is widely anticipated that at least a plurality of Southern Sudanese are in favor of partition. Moreover, this assumption is relaxed a little later in the paper when we consider democratic representation as a commitment device in the context of the 2009 elections.

[14] An alternative specification might include differentiating the costs of conflict for both actors, $\gamma_K M_J$ and $\gamma_J M_K$. This specification would accommodate the different costs associated with conflict for both actors and perhaps reflect the principal-agent problem between population and government, elected or otherwise, when it comes to waging war (We are indebted to Phil Keefer for this suggestion). The costs of war could also be expressed as a function of the intervention of the international community in favor of either side, as illustrated below.

the CPA, 2% of net Southern oil revenue is allocated to the state or region where the oil is produced and the remainder is split evenly between the Government of National Unity (GNU) and the Government of South Sudan (GoSS). To simplify matters, the state income is assumed away and oil revenues under unification are split evenly (R/2). Thus, under unity the expected payoff to Khartoum is tax revenue plus oil less military expenditures ($A+(R/2)-M_K$) and the expected payoff to Juba is tax revenue plus oil less military expenditures ($B+(R/2)-M_J$).

In the event of partition and peaceful response from Khartoum, the expected payoff is simply tax revenues for Khartoum less military expenditures ($A-M_K$) and tax and oil revenues for Juba less military expenditures ($B+R-M_J$). These payoffs reflect the fact that the majority of oil is located in the South (Upper Nile State) or in contentious border areas (e.g. Unity and South Kordofan States or the Abyei region). These assumptions are made for simplicity and are not intended to reflect the actual disposition of these areas.

If Khartoum responds to a vote for independence with war, then the payoff for Khartoum is $A+ \delta R- \gamma M_J -M_K$ and for Juba the payoff is $B+(1-\delta)R- \gamma M_K – M_J$. In addition to the non-oil tax revenues (A,B) and costs of conflict (M_K, M_J), war results in some share (δ) of the oil resources (R) secured by Khartoum through the war and the cost of conflict based on military expenditures by the other actor ($\gamma M_J, \gamma M_K$). This assumption suggests that, in the event of a military response to a partition vote, Khartoum is likely to focus its military campaign on the oil-rich areas close to the border between North and South, especially those that might be considered by Khartoum as part of the North.

[15] Strictly speaking, the CPA stipulates that the federal revenues collected by GOSS in the South should be equally shared with the central government in Khartoum. However, we abstract from this level of detail, since it will not affect the arithmetic of the game.

Therefore, the likely military response by Khartoum will not aim at restoring the full unity of the country. This assumption is consistent with the widely held view that the oil belt, including Abyei is likely to be the flashpoints for any future North-South conflict (e.g. ICG, 2008).

Assumption on the Preference for Peace: In 2005, both sides signed the CPA, ending a civil war that had been fought on and off for almost forty years. To reflect this preference for peace, it is assumed that the benefits of the peace agreement exceed any gains that either side would enjoy from conflict (formally, this is reflected by the constraint: $\delta R+\gamma M_K > R/2 > \delta R- \gamma M_J$). While this is consistent with the signing of the CPA it may be a strong assumption that may no longer hold (see discussion of military expenditure below).

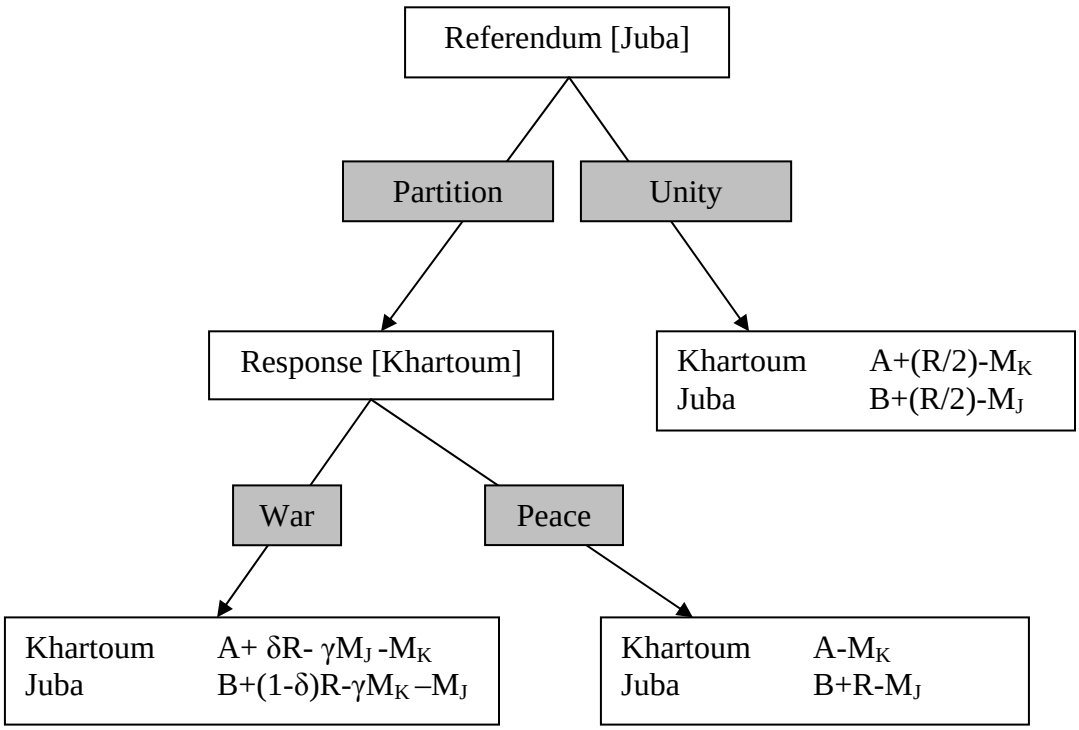
In this extensive form dynamic (sequential) game described above and shown in Figure 1, Juba is faced with a backwards induction problem. How can Juba maximize its payoff, knowing that Khartoum will respond to its choice? To solve this backwards induction problem, consider the values of the payoffs for both actors, given the three outcomes. Assuming that all five terms are positive, the payoffs for each actor have a preference ordering as follows:

Khartoum	$A+(R/2)-M_K$	>	$A+ \delta R- \gamma M_J -M_K$	> <	$A-M_K$
Juba	$B+R-M_J$	>	$B+(R/2)-M_J$	>	$B+(1-\delta)R-\gamma M_K -M_J$

Under the assumptions above, Khartoum prefers unity to war or a peaceful partition and Juba prefers partition to unity and unity to war. Khartoum's preferences between war and peaceful partition are unspecified – the analysis below demonstrates that the equilibrium obtained depends entirely upon this preference by Khartoum.

Given these preference orderings and the assumptions above, Juba's first choice would be any strategy set that will result in peaceful partition. Khartoum, meanwhile, would prefer any strategy set that would result in unity. Is it possible for Juba to force a peaceful partition on Khartoum?

Figure 1: Extensive Form Model of Referendum and Response



If the gains from conflict (δR) are greater than the costs of conflict (γM_J), then Khartoum will prefer war to peace as a response to partition[16]. If this is the case, then Juba can solve the sub-game of Khartoum's response and anticipate that Khartoum will prefer war to peace in the event of partition. In this case, Juba has a choice between the payoffs under Partition-War or Unity. Under the preference for peace assumption, Juba

[16] Even if Khartoum is not actually planning to go to war and intends to comply with the CPA, it can attempt to deter Juba from choosing the option of partition by signaling its preference for the war option.

would prefer unity to war ($R/2>(1-\delta)R-\gamma M_K$). In this scenario, Khartoum has a credible threat of war and Juba's only rational choice for the referendum is unity, despite their preference for peaceful partition.

If, however, the gains from conflict are less than the costs of conflict ($\delta R< \gamma M_J$), then Khartoum prefers peace to war in the event of partition. Following the same logic as above, Juba can use backwards induction to anticipate Khartoum's response to a vote for partition as peace. The two choices in this case would be between the payoffs of Partition-Peace and Unity. Following the preference ordering above, Juba prefers the payoff under Partition-Peace over that of Unity. In this case, because Khartoum has no credible threat of war, Juba can provoke a peaceful partition through a referendum vote. These results are presented in Table 1, below.

Table 1: Payoffs from Pure Strategy Nash Equilibria for the Game of Referendum and Response

	$\delta R> \gamma M_J$	$\delta R< \gamma M_J$
Khartoum	$A+(R/2)-M_K$	$A-M_K$
Juba	$B+(R/2)-M_J$	$B+R-M_J$

As these results show, the Nash equilibrium solutions depend entirely on expected costs and gains from conflict. Of course, these are simplified payoffs and objective functions and the reader is cautioned to remember that the opportunity cost of military spending is often development. In this respect the costs of conflict, actual or threatened, are underestimated in this model. In the next section we discuss the impact of military expenditure and other actions by both actors in determining these parameters.

2.1 Military Expenditure and Other Investments in Credible Threat

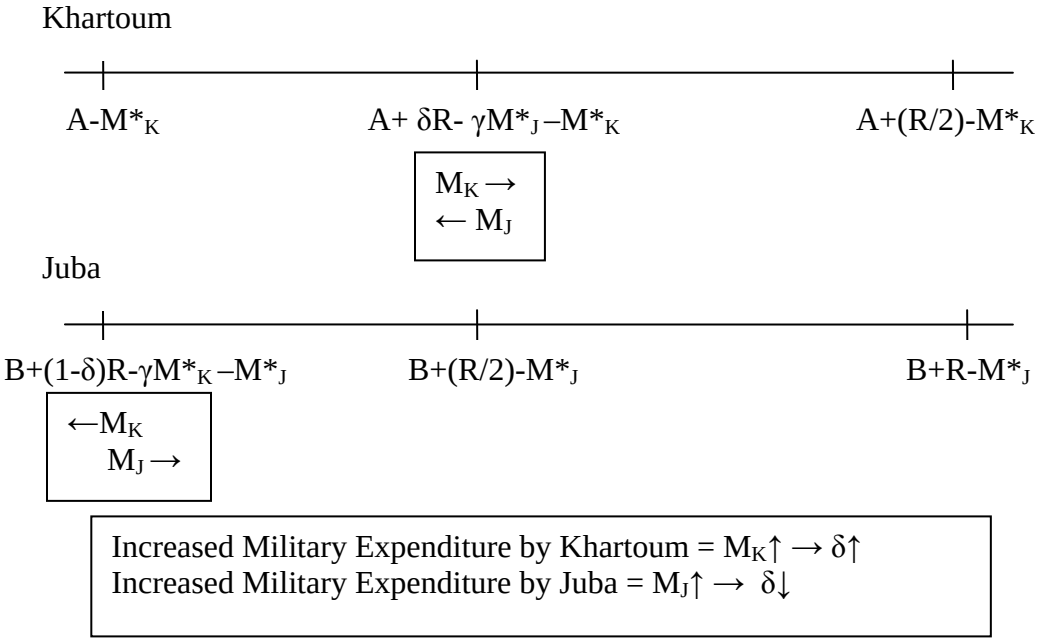
In this model it is the relative values of the costs of conflict (γM_J) and the gains from war (δR) that determine whether Khartoum's threat of war is credible. Assuming that δ is a function of M_K and M_J, both actors are able to affect these costs and benefits through military spending[17]. For all $\gamma>0$ military spending by each side increases the costs of conflict for the other actor. We assume a unique equilibrium levels of expenditure for both actors which we represent by M^*_K and M^*_J. In terms of the model presented in Figure 1, these levels of expenditure would be set in a "pre-game" stage where both actors set M^*_K and M^*_J as if they were going to war (following the logic that both must have credible threats of conflict developed in the previous section)[18].

This relationship between military expenditure and the costs and gains from war is graphically illustrated by locating the preferences orderings from above on to two number lines in Figure 2.

[17] This relationship defining δ could take a functional form such as a contest success function, following Hirshleifer (1991) and Skaperdas (1996).

[18] In this case, both agents maximize their payouts from war, given their opponents expected payouts, resulting in solutions that satisfy the first order conditions $\delta'=1/R$ for Khartoum and $(1-\delta)'=1/R$ for Juba. We assume that the solutions M^*_K and M^*_J are unique and positive.

Figure 2: Military Expenditure Effect on Payoffs



On the first number line, reflecting Khartoum's payoffs, military expenditure by Khartoum can move the payoff for war up and above the payoff from peaceful partition (as shown in the figure), ensuring that the threat of conflict is credible. Meanwhile, military expenditures by Juba could reduce this payoff for Khartoum through two channels: share of resources secured through war (δR) and costs of conflict proportional to military expenditure by Juba (γM_J). These expenditures by Juba decrease the expected payoff from war for Khartoum. Conceivably, very high spending by Juba could reduce the payoff to Khartoum below that of peaceful partition. Such spending by Juba is a deterrent, reducing the credibility of Khartoum's threat of conflict. Similarly, increased military spending by Juba moves the payoff from war to the right for Juba on the second number line and spending by Khartoum on the military moves the payoff for Juba to the left on the number line. Conceivably, very high levels of expenditure by Juba vis-à-vis

low spending by Khartoum and a low level of γ could result in Juba preferring war to unity, but we assume away this possibility with the preference for peace. However, this possibility should serve as a caution against any international intervention which would serve as a substitute for (or more likely, augment) military spending by Juba.

As shown in the previous section, even if neither actor has an interest in going to war, both actors have an incentive for military expenditure to reduce their opponent's gains and make conflict as costly for their opponent as possible. This rationale explains the very high levels of military spending by both the GNU and GoSS[19]. According to the World Bank's 2007 Public Expenditure Review (PER) for Sudan, the GNU's expenditure for defense and national security in 2006 was 325.6 billion Sudanese Dinar (1.175 billion US$). This represented 19.8% of total government expenditure for the GNU. Security expenditures for GoSS in 2006 were 555 million US$, representing 41.7% of the South's government expenditures[20]. As Figures 1 and 2 demonstrate, even if Khartoum has no interest or intention of going to war, it has every incentive to maintain a credible threat of war to ensure that Juba will choose unity in the referendum. Likewise, even if Juba has nothing to gain from conflict, it must make conflict as costly as possible for Khartoum to prefer peace over war if peaceful partition is to be a real strategic option for Juba[21]. Unfortunately, this is the logic of conflict; non-productive military expenditure is a

[19] For example, a recent ICG (2008) report argues that (p. 1)," having concluded that it cannot rely on the guarantors, the SPLM has been building up its military capacity, which many members consider its only realistic leverage over the NCP, as well as developing alliances with marginalized movements and rebel factions within Darfur, Kordofan, the East and the far North."

[20] Figures from the CPA Monitor for the 2007 budgets are different and may reflect changes in spending from 2006 to 2007 as well as differing definitions. The CPA Monitor lists the total budget for the security sector for the GNU at US$375 million. Military spending for GoSS is listed as US$592 million. These statistics are the most readily available and most accurate, though discrepancies clearly exist. The PER figures are consistent with the CIA World Factbook estimate of Sudan's military expenditure of 3% of GDP (which would suggest US$ 1.13 billion spending on defense for GNU in 2006).

[21] For an analysis of military expenditure as a cause, not an effect, of post-conflict relapse into violence, see Collier and Hoeffler (2006).

perfectly rational response even when both actors might benefit from spending less on security (Hirshleifer, 1991, Skaperdas, 1996).

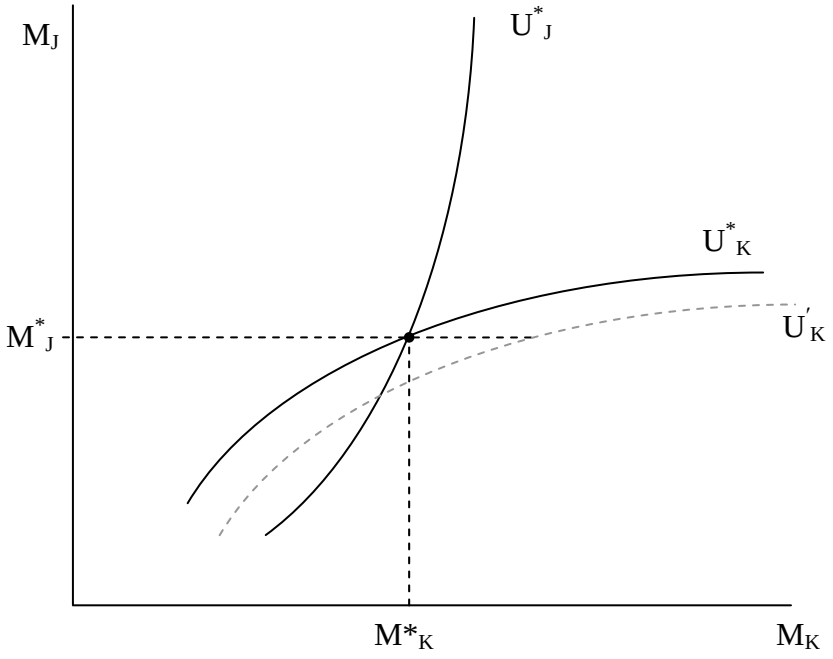
This relationship is graphically represented in Figure 3, in which indifference curves (U^*) for both actors are shown and the current equilibrium determined by military expenditures, M^* for each actor. We assume diminishing returns to military expenditure and constant costs for military spending resulting in indifference curves that are concave in military expenditure[22]. These assumptions reflect the geographical and fixed nature of the resources (R) to be divided by conflict – given an opponents military expenditure, the first percentile of R arranged in ease of appropriation would be less costly to secure than the 99^{th}.

Lower military expenditure by an opponent increases the utility for an actor, therefore the indifference curve U′ represents higher payoffs for Khartoum than that of U^*. Though Khartoum might want to decrease military expenditure, this would only result in decreased payoffs (a lower valued indifference curve, farther away from the M_K axis), assuming that Juba will maintain expected military expenditure of M^*_J. The indifference curves and similar constraints hold for Juba, causing Juba to maintain M^*_J. The optimal solution for each actor is a vector of responses which are represented by a response curve not shown in the figure. In the unique Nash equilibrium, both actors maximize their military expenditure taking into account constant costs of military expenditure and respond to their opponents expected expenditures – thus the Nash equilibrium shown is the intersection of the best response functions for both actors.

[22] For example, a simple ratio form contest success function $\delta=\mu M_K/(\mu M_K + M_J)$, where μ is a decisiveness parameter that determines the effectiveness of military spending by Khartoum relative to Juba is used to represent δ, the share of R secured through military action. Maximizing utility for both actors results in equilibrium levels of military spending for both actors of $M^*_K=M^*_J=\mu R/(1+\mu)^2$ These results and the best response functions for both actors result in concave utility functions for both actors, like those in Figure 3.

Because both responses are best responses for both actors, the equilibrium solution holds at M^*_K, M^*_J. This tension between the incentive to invest in the military while avoiding escalation, creates the backdrop against which both actors can invest in their military while simultaneously pledging peace.

Figure 3: Military Expenditures and Outcomes under Assumption of War



While $\{M^*_K, M^*_J\}$ is a unique equilibrium solution, Figure 3 demonstrates that the inclination of both actors is to increase military spending given their opponent's expenditure. This equilibrium holds because at M^* marginal value of military expenditure is equal to the cost - diminishing returns keeps each actor from trying to move to U' from U^*. Figure 3 also demonstrates that this equilibrium level of expenditure is excessive because there is a region where both actors could reach higher

indifference curves by decreasing military expenditures (southwest of the equilibrium solution). Because military expenditure is non-productive, both actors would prefer to divide the prize from conflict with minimal military expenditure. However, because neither actor can credibly commit to these lower levels of military expenditure, such an equilibrium cannot be reached. We return to this issue when we discuss how democratization can serve as a commitment device allowing both actors to reach preferred outcomes with lower military expenditure.

In addition to excessive military expenditure by both sides, another reflection of this "race to the bottom" is evident in the extremely slow formation of the Joint Integrated Units (JIUs), a force of nearly 40,000 personnel, mandated by the CPA and intended to be formed out of equal parts from the Sudan Armed Forces (SAF) and the Sudan People's Liberation Army (SPLA) troops. While the JIUs were defined by the CPA in 2005, formation of Joint Military Teams (JMTs) and nomination of forces to serve in the JIUs fell behind schedule, missing the scheduled deployment for October 2006. To place the size of this force into perspective, the SAF has approximately 105,000 total active troops and the SPLA consists of 20,000 to 30,000 active troops (Military Balance, 2007). As a result, the full verification and deployment of a unity force less than one third of the size of the total fighting forces available to both sides, remains behind schedule. Though there is some hope as limited progress has been made recently (see UN Security Council Resolution 1784).

Unfortunately, reported military expenditure is not likely to reflect the full range of options exploited by both sides to increase the cost of war for the other. For example, Khartoum has historically exploited tribal differences within the South by training,

arming and financing militias from Southern Sudanese tribes that have been historically non sympathetic to the SPLM. This is has been a bone of contention between the NCP and the SPLM, which demanded the dissolution of these militias. On the other hand, the SPLM has been able to mobilize allies from the so called transitional regions of Southern Kordofan and Southern Blue Nile, which are part of the North. Military Balance estimates the size of the paramilitary "Popular Defense Force" as 17,500 active with 85,000 reservists[23]. In addition, the more populous and powerful Arab nomadic tribes in South Darfur (who have largely not been part of the Darfur conflict)[24] and Kordofan are likely to be drawn into the conflict against the SPLA in the context of a dispute on Abeyei or other border areas[25]. In these respects, investments in alliances can be likened to military spending, decreasing the costs of conflict for each actor and increasing the possible gains. Indeed, this brinksmanship is apparent in Sudanese President Omar al-Bashir's October mobilization of some of these allied forces, "Now we order the Popular Defense Force (PDF), the legitimate son of the people, to open their camps and gather their mujaheddin" to which he added that the purpose of this call was "not to wage war" but that "it is obvious we should be ready" (IWPR, 2008). This, corroborates the main premise of our model as President al-Bashir, representing Khartoum, has an incentive to signal a strong willingness for conflict even if he has no intention of going to war.

[23] Recent reports suggest that the Janjawid in Darfur may be being assimilated into the Popular Defense Forces, suggesting that measures of total military expenditures and force size in the north may not reflect actual strength of Khartoum (Winter and Pendergast, 2008). How and whether these forces would be employed in conflict with the South is unclear.

[24] See for example, Flint and De Waal (2005).

[25] Indeed, the recent bloody skirmishes (January and February 2008) between the SPLA and the Messeriya tribesmen over grazing lands around Abyei and Abak is a testimony to this potential conflict. For details on these events, see the *Media Monitoring Reports* from the United Nations Mission in Sudan (UNMIS), specifically January 7 and February 24, 2008.

2.2 Incomplete Information

The previous section demonstrated that in the referendum model with complete information equilibrium solutions depend on the expected costs and gains associated with war, even if neither actor has an interest in going to war. Under the assumptions for the previous sections, war is never an equilibrium, since both actors have a preference for peace and can respond to the predicted behavior of the other actor. Now we relax our assumption on complete information of the payoffs, allowing for incomplete and asymmetric information on the gains from conflict (δ). As shown in the previous section, only the relative values of the costs and gains of conflict are important for determining the equilibrium solutions, therefore, it is assumed here that the only incomplete information is in the gains from (δR) associated with conflict (Juba: Partition; Khartoum: War)[26].

For simplicity, we assume two possible values for the gains from conflict, referred to as δ_{Low} and δ_{High}. Unlike the analysis from the previous section, here we hold military expenditures by both sides fixed, so that neither actor has the ability to change the payoffs from war and must respond strategically to given payoffs. δ_{Low} is defined such that the gains from conflict less the costs of conflict are negative. δ_{High} is defined such that the gains from conflict, less the costs of conflict are positive, yet not so high that unity is no longer attractive to Khartoum (the preference for peace still binds). Formally, these assumptions imply:

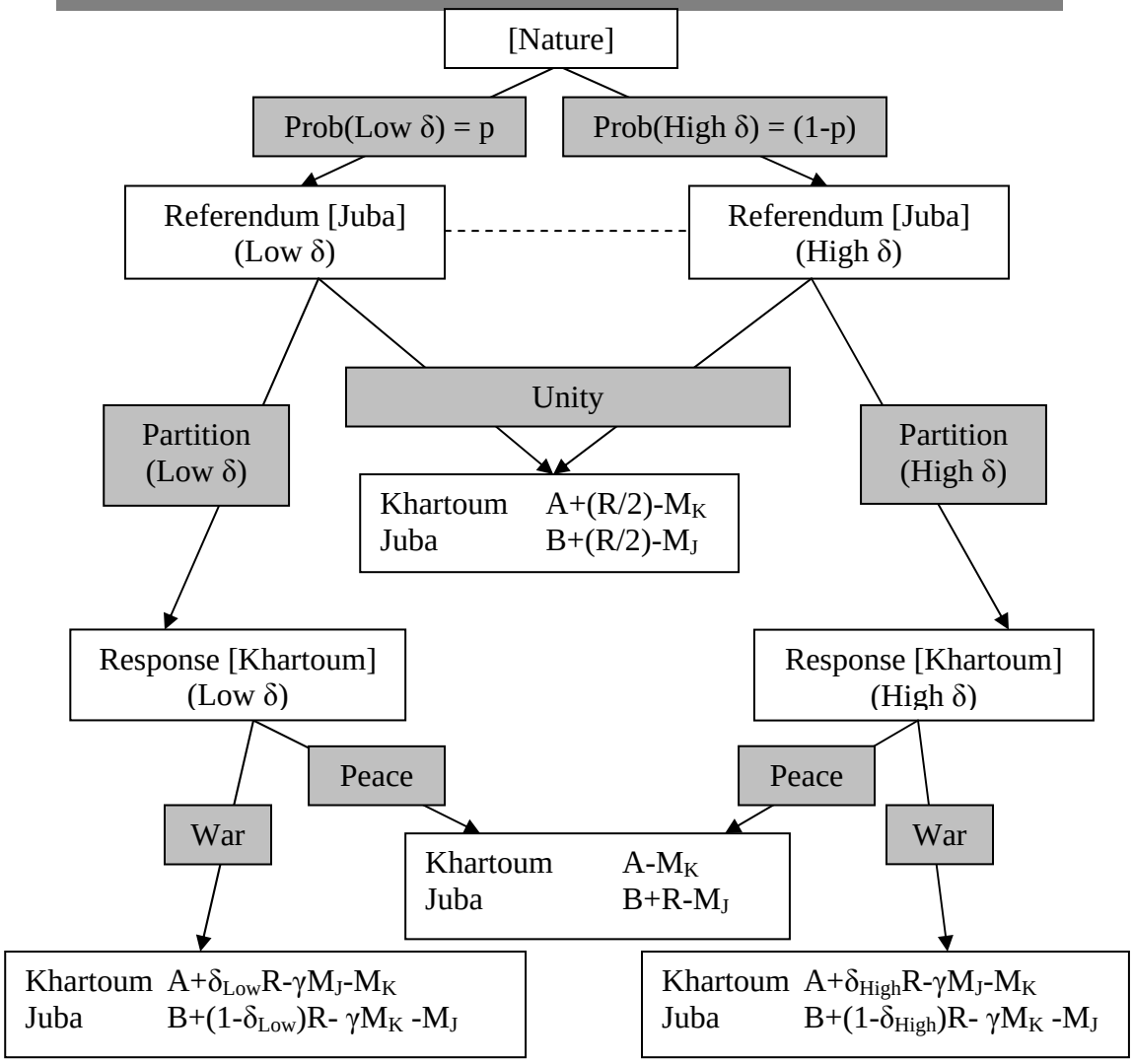
$$\delta_{Low} R < \gamma M_J \quad \text{and} \quad \gamma M_J + (R/2) > \delta_{High} R > \gamma M_J$$

[26] Clearly the model would be more realistic if this assumption was relaxed and more of the parameters included incomplete information, however, the results would be unnecessarily complicated without significant gains in understanding the relationship between the two actors.

The state of δ, is determined randomly by "nature" before the game begins with probability (p) that δ_{Low} is chosen. This implies that the probability of being in the δ_{High} state of nature is (1-p). It is assumed that the information is asymmetric: Juba knows the probability of being in each state, but not the actual state, while Khartoum knows the probability and the actual state of nature.

This incomplete information is represented by the dashed line between the choice nodes for Juba, indicating that Juba does not know if it is playing the δ_{Low} or δ_{High} sub-game (Figure 4). Because δ is not a component of the Peace or Unity payoffs, the state of δ only affects the War payoffs for both actors. Thus, with the exception of the two possible states of δ, the incomplete information game in Figure 4 is identical to that of the extended form game in Figure 1.

Figure 4: Extensive Form Model of Referendum and Response with Incomplete Information



If Juba chooses Unity, the state of nature does not matter (the payoffs are the same regardless of the state of nature). However, if Juba chooses Partition, the possibility of being in a low or high state affects Khartoum's response, therefore backwards induction with probabilistic expectations can still be used to find the equilibria for the sequential game, even though Juba doesn't know which game is being played.

Following the same logic as in the previous section, Khartoum will respond to Partition with War if the δ_{High} sub-game is being played and will respond with Peace if the δ_{Low} sub-game is being played. Thus, if Juba chooses Partition without knowledge of the state of nature it can expect a payoff of: $p(B+R-M_J)+(1-p)(B+(1-\delta_{High})R- \gamma M_K -M_J)$. If this payoff is compared to the payoff from Unity, Juba will prefer Partition, even at the risk of war, provided that $R(1-2(1-p)\delta_{High})>2\gamma M_K(1-p)$. Ceteris paribus, as p increases the likelihood of being in a δ_{Low} state increases and Juba is more likely to benefit from Partition.

The preference calculation is simple and fairly straightforward, but Juba's decision is non-trivial. While there are implicit assumptions that Juba is risk neutral and that the payoffs truly reflect the cost of conflict, it should be noted that the decision for Partition by Juba is accompanied by an ex ante (1-p) probability that Khartoum will respond with War. Here, even if both actors prefer Unity to War under the preference for peace, it is still possible for war to occur if the payoff to Juba from Partition is sufficiently high.

While this version of the model is fairly similar to the basic one presented at the beginning of the paper, it is evident that the introduction of asymmetric and incomplete information is costly for the actor with less information and can be costly for both actors. If Juba was guaranteed complete information about the state of nature it could use backwards induction and calculate the ex ante payoff from playing this game. This ex ante payoff would be the sum of the probability weighted payoffs from each equilibrium that follows from each state of nature. Moving the expectations operator through these probability weighted outcomes yields $B+R((1+p)/2)-M_J$, which exceeds the unity payoff

by (p/2)R, a premium Juba would be willing to pay for this information if they were concerned about going to war (i.e. if they are not risk neutral).

The value of this information to Juba and the possibility that asymmetric information might contribute to war, even when neither actor's first best solution is war, suggests that more complete information might benefit both actors. Unfortunately, in this one shot game (there will only be one referendum in 2011) a credible signal on the state of nature cannot be sent by Khartoum. With incomplete and asymmetric information, there is the possibility that the state of nature is δ_{High} and that Juba still chooses Partition, to which Khartoum responds with War. While both actors would prefer Unity to war in this case, Khartoum cannot credibly signal the state of nature, because it always has an incentive to signal that the state of nature is δ_{High}. The earlier quotation by President al-Bashir reflects the incentives for Khartoum to signal this strength.

The limitations on credible signals from Khartoum and the value of more complete information are both part of the dilemma of a continued peace in Sudan. Still, this analysis suggests an area for possible contribution by an international community interested in securing the peace between Juba and Khartoum. The game of incomplete information shown here is just one example of the many ways in which incomplete information could result in war when neither actor prefers war. More complete information provided to both actors could reduce the probability of unwanted conflict. To that end, the mapping exercises, explicit resolution of Abyei border issues and the CPA mandated census which has fallen behind schedule and is now planned for early 2008 could contribute to better informed strategy choices (policymaking) from actors in both the North and the South. All of these activities would contribute to a more explicit

and transparent assessment of the size of the parameters described in the model, including non-oil revenues, oil revenues and the number and location of citizens, statistics which would contribute to a better understanding of the costs of conflict. Likewise, more extensive transparency in government and military expenditures by both actors (verified by third parties) following the example already set by the CPA Monitor could contribute to more complete information and reduce the likelihood of unwanted conflict.

Additionally, note that asymmetric information was assumed here for convenience, not to reflect the actual conditions on the ground in Sudan. If, more realistically, we assume that each side faces uncertainty about the other's expected gains from going to war and that each can increase military expenditures, then, given some very reasonable assumptions on the parameters, Khartoum could have an incentive to increase its military spending to discourage Juba from opting for partition, while Juba might want to build up its military power to deter Khartoum from responding to partition with war. If there is any dynamic feedback from observed military spending to actual military spending, this could result in an "arms race" that could be quite dangerous in a situation in which both actors do not know the other's payoff associated from war (and have incentives to signal that the payoffs are high). Military spending may in fact lead to a situation in which the actors' preference for peace is overcome and they prefer to go to war regardless of the other's actions. In addition, the existence of private information and incentives to misrepresent that information can lead to war through another causal mechanism, which does not require overcoming the preference for peace. Both actors may start feeling threatened by the other's military spending, perceived as aggressive,

and may consider the opportunity of launching a preventive attack if they think that their chances for success are better in the present than at the end of the "arms race"[27].

3. Democratization as a Commitment Device: The Upcoming 2009 Elections

Recent research of elections in post-conflict states suggests that elections following a peace agreement are accompanied by higher risk of conflict relapse (Collier, Hoeffler and Soderbom, 2007). In addition, several studies have found that democratizing states tend to be especially war prone when they do not have strong institutions at the moment of political transition (see in particular Snyder, 2000, and Mansfield and Snyder, 2005). In the absence of strong institutions, electoral politics in transitional countries tend to be hijacked by opportunistic politicians that use nationalistic and ethnic rhetoric to win votes thus increasing the risk of violent conflict, both at home and abroad. However, we believe that this scenario is less likely in Sudan as the foundations already exist for non-factional democratization because the CPA and the new interim constitution enacted after the signing of the agreement have laid the foundation for a participatory federalized democracy.

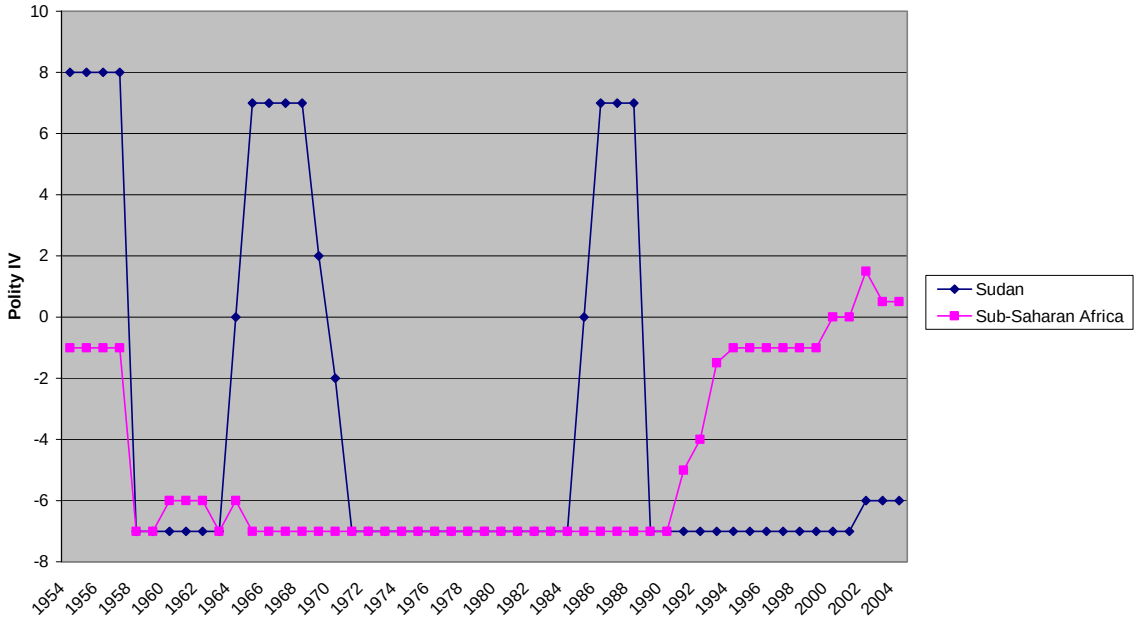
Moreover, reneging on obligations to the peace agreement by the NCP or SPLM is likely to be very costly for both actors, due to the presence of active political parties and civil society organization in both North and South. The political landscape in Sudan today is extremely dynamic involving historical parties with substantial popular base, such as the Umma Party, as well as aggressive regional political movements in the so

[27] See Fearon (1995) for a theoretical discussion of private information and incentives to misrepresent it as a cause of war.

called “marginalized” North, such as Darfur. Also, the SPLM is also likely to face a vigorous contest from a combination of smaller historical parties and other community-based movements. In addition, Sudan has a legacy of democratic rule that during its short rein in power (1956-58, 1964-69, 1985-89), and despite the civil war, had afforded the country a decent degree of political competition and political rights, well above the median for SSA (Figures 5 and 6). However, following the coup in 1989, Sudan became a restricted, factional authoritarian state according to the Polity IV dataset. This lasted until recently when it graduated to a restricted competition state since 2002, reflecting the diminishing capacity of the NCP to control political opposition and the strengthening role of political parties that transcend ethnic factions. The increasing role of such parties is important because recent evidence suggests that while non-factional democratization promotes peace and development, winner-take-all factional democratization is strongly correlated with political violence and underdevelopment (Bodea and Elbadawi, 2006, 2007).

As a measure of political competition (Polity IV) suggests, despite some improvements following the cessation of hostilities and the start of the peace negotiations, the regime is still very authoritarian, in absolute sense as well as relative to the median Africa country (Figure 5). Despite having identical polity scores in 1989 and 1990, the democratization path for Sub-Saharan Africa diverged over the 1990s and a sizeable gap of approximately 8 points in polity remains between Sudan and the median African state.

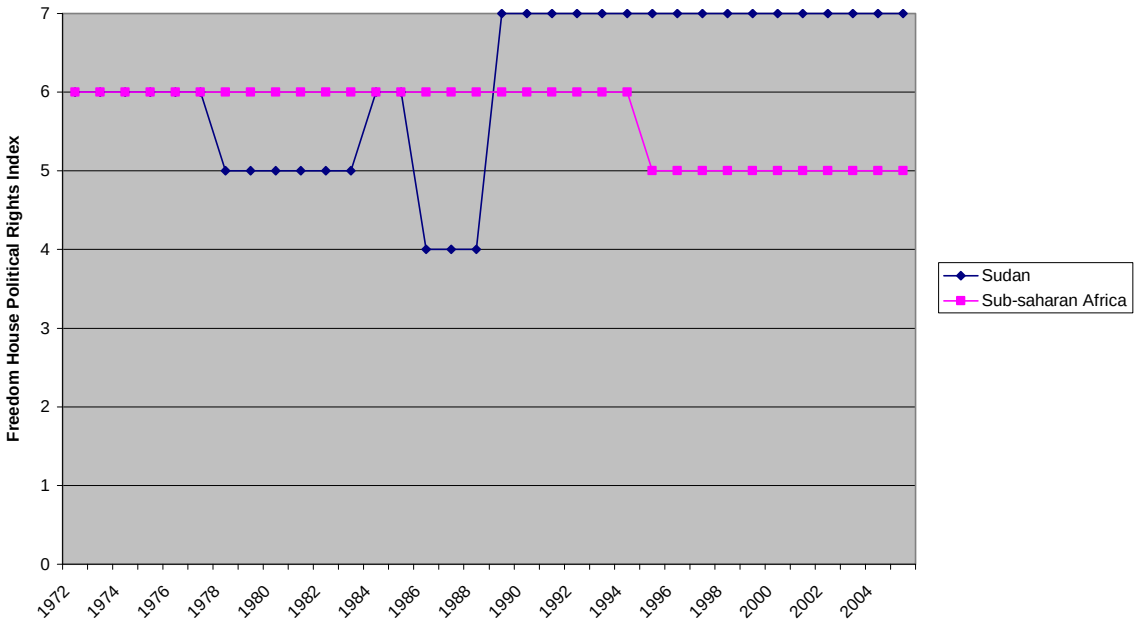
Figure 5: Sudan's Democratic Performance vis-a-vis the Median Sub-Saharan Africa Country (1954-2004), Polity IV



Note: the index ranges from -10 (most autocratic) to 10 (most democratic).
Source: Polity IV.

The divergence in democratization is also apparent in the measure of political rights compiled by Freedom House (the Gastil Index, shown in Figure 6). Despite similar levels of political rights in the late 1980s and early 1990s, political progress in Sub-Saharan Africa has resulted in the median SSA country being termed "partially free". Meanwhile, the people of Sudan are considered "Not Free" by the Freedom House index of political rights.

Figure 6: Sudan's Democratic Performance vis-a-vis the Median Sub-Saharan Country (1972-2005), Freedom House Political Rights



Note: The index ranges from 1 (free) to 7 (not free).
Source: Freedom House 2007.

Given the current state of democracy and the legacy of political oppression, it might not be realistic to expect fundamental change in the level of democracy in the next three years. Still, we contend that free and fair elections in 2009 (as mandated by the CPA) that would lead to more democratic governments in both Khartoum and Juba would more accurately reflect the interests and will of all of the people of Sudan, including the interests of Juba.

We contend that because both actors (especially Khartoum) face a credibility constraint, even limited democratization in the upcoming election could serve as a useful commitment device and resolve some of the credibility issues that are currently contributing to excessive militarization by both actors and the possibility of unwanted

conflict. Khartoum enjoys the privilege of acting last in the sequential game and therefore, the benefits accruing to a credible threat and the limitations of non-credible signals both fall primarily on Khartoum. Therefore, the following model considers the impact of increasing the credibility of Khartoum through limited democratization. This extension of the political franchise could result in credible commitments to limited militarization and a peaceful partition or, perhaps even unity, which would otherwise be impossible[28]. To reflect this, the sequential game from Figure 3 is expanded to allow for another stage, namely an election, in the model presented in Figure 6.

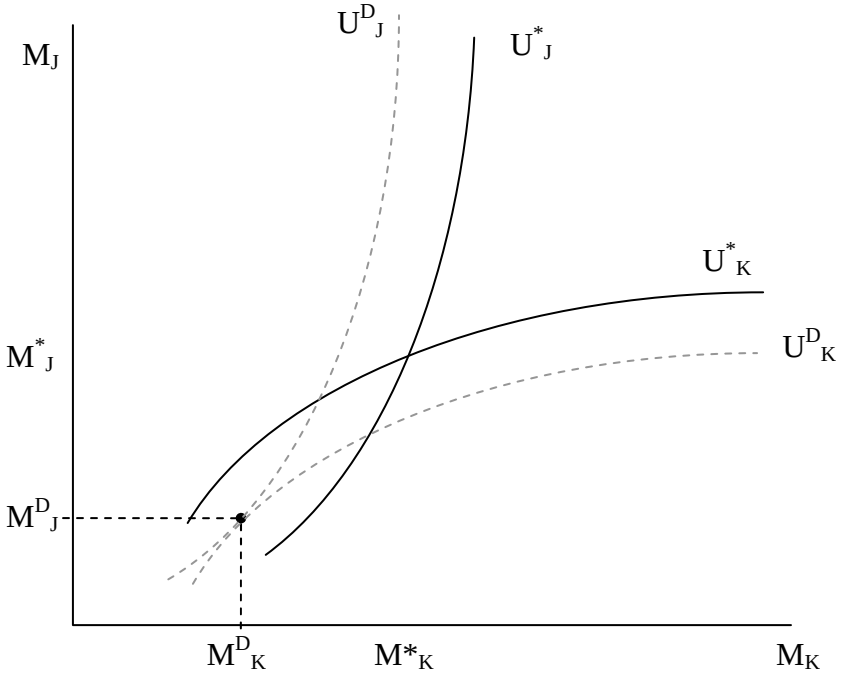
In the model of referendum and response with an election, Khartoum acts first, deciding whether to have a free and fair election resulting in limited democracy or whether to have an election without democratization, resulting in the continued authoritarian status quo. If Khartoum democratizes, then both actors enter the democracy sub-game. However if Khartoum does not democratize, it maintains the ability to respond to partition as in the previous models, so the expected result is as follows from the basic game presented in Figure 1.

We assume that under democratization, all of the actors are able to share information and are able to negotiate a credible reduction in level of militarization in the North and the South. This would have to follow the process of a very real democratization, not simply democratization in name, wherein all actors would engage within the political system to resolve these very pressing issues. Ignoring for the moment all of the other possible fruits of such an outcome, assume that this democracy focuses on a limited agreement on military expenditure. Let M^D_K and M^D_J represent military

[28] Here we follow Jack and Lagunoff (2006) and Gehlbach and Keefer (2008) in arguing that democratization can serve as a commitment device for otherwise non-credible elites.

expenditure under democratization. This new, negotiated and credible level of military expenditure is shown in Figure 7.

Figure 7: Military Expenditures and Outcomes under Assumption of War and Democratization



We assume that an agreement can be reached under democratization is equivalent to or preferred to the outcomes without democratization (from Table 1), formally:

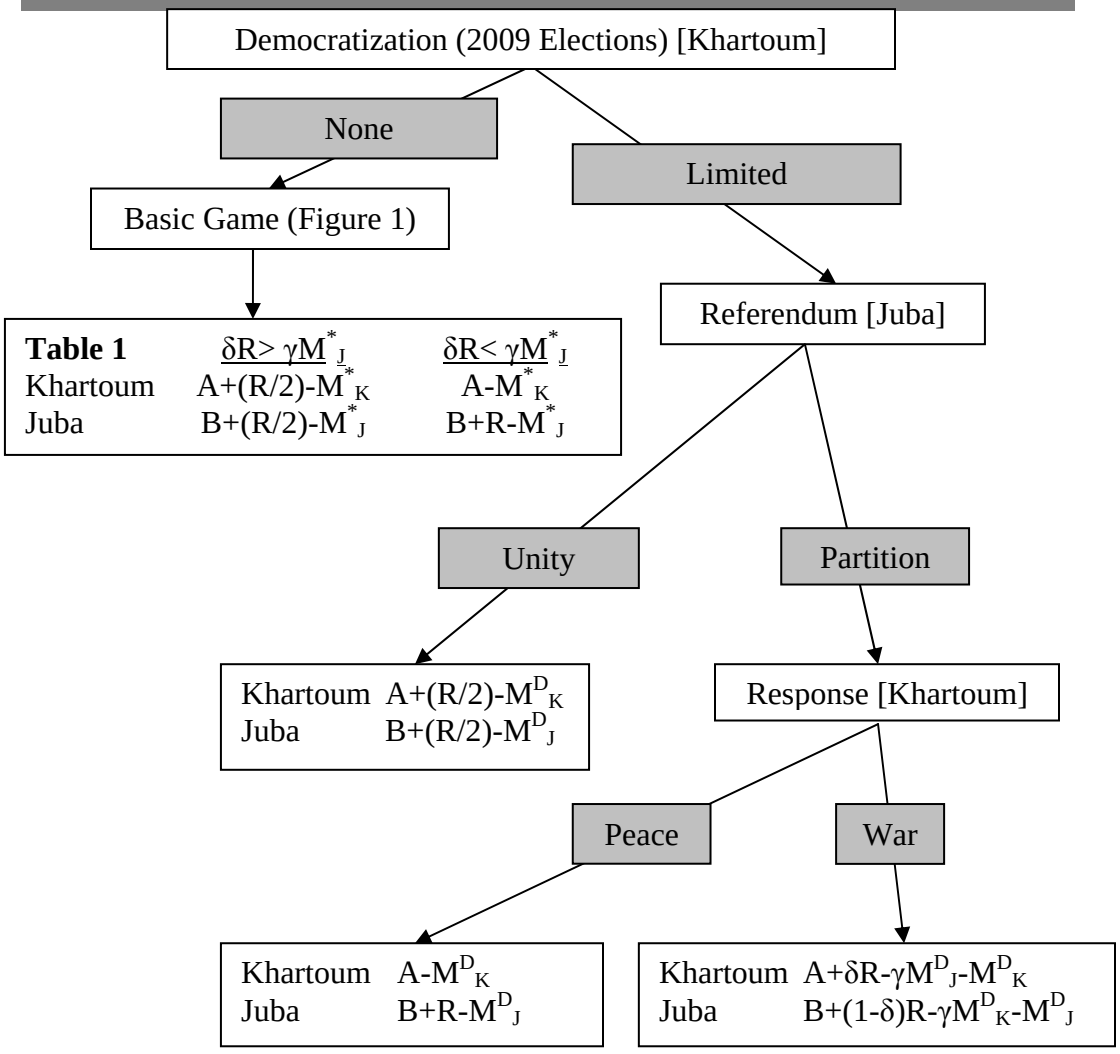
For Khartoum: $\delta(M^D_K,M^D_J)R-\gamma M^D_J-M^D_K \geq \delta(M^*_K,M^*_J)R-\gamma M^*_J-M^*_K$

For Juba: $(1-\delta(M^D_K,M^D_J))R-\gamma M^D_K-M^D_J \geq (1-\delta(M^*_K,M^*_J))R-\gamma M^*_K-M^*_J$

and for both actors: $M^*_K>M^D_K$ and $M^*_J>M^D_J$.

These payoffs are shown in Figure 8, where the sub-game without democratization is substituted by the sub-game perfect Nash equilibria determined in the first model.

Figure 8: Extensive Form Model of Referendum and Response with an Election



Under these assumptions, the solution for the democratization game is similar to that of the non-democratization game, with some very important distinctions. If the level of democratization is such that this level of militarization is credible on both sides, then the payoffs for each actor i for every outcome increase by $M^*_i - M^D_i$, suggesting that

democratization would be pareto preferred by both actors[29]. Additionally, in the event of war, the total costs from war decrease by $\gamma(M^{*}_{K}+ M^{*}_{J}-M^{D}_{K} - M^{D}_{K})$. Also, if democratization can contribute to control of the military spending, such a solution would decrease the likelihood of an arms race and the possibility of both actors engaging in a preventive war that follows due to commitment problems.

4. Simulations: Some Estimates of the Parameters

Here we provide some basic estimates of the parameters following from the few statistics available. This numbers are very rough and should be taken as such. They are intended to provide a brief glance at the models and payoffs for both actors and it is hoped that they will contribute to the ongoing dialogue between the actors and the international community on the true costs of war and peace for the Sudan.

Table 2: Estimates of Terms in Payoffs (2007)
(all figures are in million $, except number of troops)

	GNU		**GoSS**
Total revenue	5,546[a]		1,419[b]
Non-oil revenue	3,416[c] (A)		65[d] (B)
Oil revenue	2,130[e]		1,354[f]
Total Contested Oil Revenue (R)		2749.6	
Defense and security expenditures	1,175		555[g]
Defense and security + Public order and safety expenditures[h]	1,500		717
Number of troops[i]	122,300		25,000
GDP		46,708	

[29] Here, a critical reader may argue that the assumption on unitary actors is unreasonable, as the payoffs for the elites in Khartoum are not necessarily aligned with those of the rest of the North. Similarly, the decision of southern nationalists that might commit to war may not reflect the payoffs of the population of the South. Still it is in this political space, in light of the gains from democratization and demilitarization, where real negotiations with the elites in Khartoum could begin, bringing their objective functions into alignment with the rest of the population of the North. (We are indebted to Stephen Ndegwa for thoughtful commentary on these issues).

Cost of war	49,011[j]

Sources: World Bank, Public Expenditure Review 2007; IMF, World Economic Outlook 2007; CIA, World Factbook 2007; Economist Intelligence Unit, Country Report 2008; International Institute for Strategic Studies, *Military Balance 2007*.

a. Net of oil revenue transfers to the GOSS (US$1362m). May include grants, unspecified in 2006 World Bank Public Expenditure Review for Sudan.

b. This figure includes US$1331m reported in the GoSS budget and US$87.6m, reported in the GNU budget as oil revenue transfers to Southern oil-producing states (i.e., Unity and Upper Nile). The two figures were summed up for comparability with GNU revenues, which include sums to be transferred to Northern states. Total contested oil revenue is twice the value of transfers from GNU to GoSS plus transfers to oil-producing states.

c.This figure probably includes donor grants.

d. This figure includes donor grants (US$63m) and GOSS tax revenue (US$2m).

e. Net of oil revenue transfers to the GOSS.

f. This figure includes the oil revenue reported in the GOSS budget (US$1266m) and the oil revenues transferred by the GNU to the oil-producing Southern states (US$88m).

g. This section of GOSS budget expenditures is called "Security". US$552m out of US$555m were allocated to the SPLA.

h. For the GNU this row corresponds to the sum of amounts spent for "Defense and National Security" and for "Public order and safety". For the GoSS this row corresponds to the sum of "Security" and "Rule of Law".

i. The figure for the GNU includes 104,800 regular troops and 17,500 paramilitary troops. The figure reported for the GOSS is in the middle range of the estimated strength of the SPLA (20,000-30,000).

j. The cost of war is calculated as the net present value of forgone economic growth, which has been estimated by Collier and Hoeffler (2004) as equivalent to 105% of current GDP, assuming a war that last seven years and fourteen years of recovery. The GDP figure used for the calculation is the IMF estimate for Sudan's 2007 GDP.

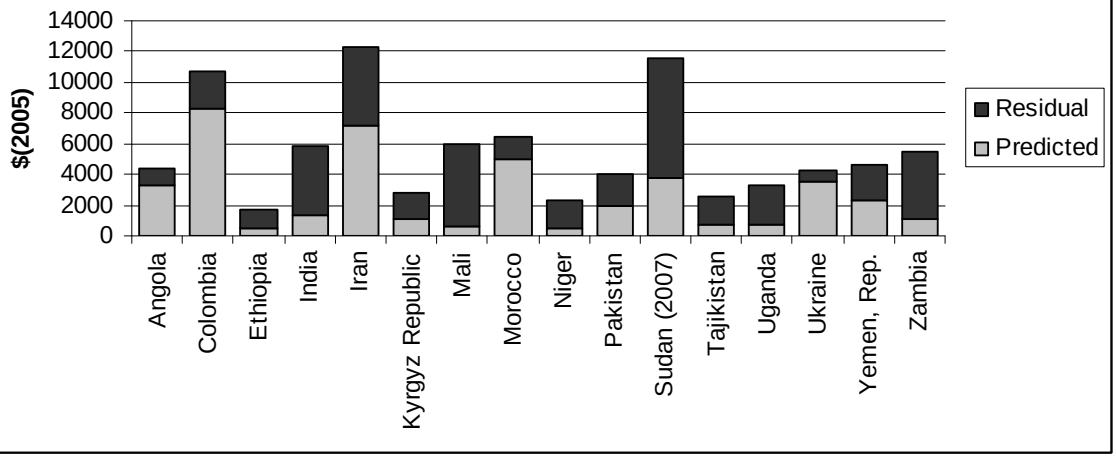
The source used for all revenue and expenditure information in Table 2 is the World Bank's Public Expenditure Review for the year 2006. The figures on military forces are from the Military Balance (2007). We use Collier and Hoeffler's (2004) findings to estimate the overall cost of the conflict. They found that on average the discounted cost of civil war is equal to about 105 percent of GDP at the start of the conflict.[30]

Table 2 begs the question of the sustainability of these levels of military expenditure in the event of partition. Without US$1331m in oil revenues for Khartoum, it is difficult to conceive that they would be able to continue to spend US$1175m on defense and military (34% of $3416m non-oil government revenues), though security concerns, such as the one in Darfur, may necessitate high military expenditure. Similarly, while some degree of "catch-up" military expenditure is understandable in the

[30] Part of the cost is incurred during the conflict, because the war on average reduces growth by 2 percent of GDP. After the conflict, the cost is represented by the fact that it takes long time (on average 14 years) for the economy to recover completely from the shock; during this period, the GDP is lower than it would have otherwise been without conflict. This is a conservative measure of the costs of civil conflict because it does not account for the costs of loss of life and disability (Collier, Chauvet and Hegre, 2007). The negative externalities associated with spill-over of conflict (e.g., refugee flows, communication of diseases and terrorism) are not taken into consideration here, because we are interested in the costs of conflict that are directly borne out by Juba and Khartoum.

South, annual expenditures of US$555m with current non-oil revenues of only $60m suggest that a large percentage of any significant military expenditure in the future necessitates control of oil wealth. Average military expenditure as a percentage of government expenditure for most low and middle income countries is 14-15%. To place these expenditures in perspective, we run estimates of military expenditure per capita and per soldier for a panel of 91 developing countries from 1990 to 2005. We predict expenditures for these countries, controlling for the variables reported in Appendix Table 1, including GDP per capita, population, area of the country, level of democracy and whether the country is landlocked[31]. In Figure 9 we report the predicted and residual military expenditure per soldier for only those countries with positive residuals in all four models from Appendix Table 1.

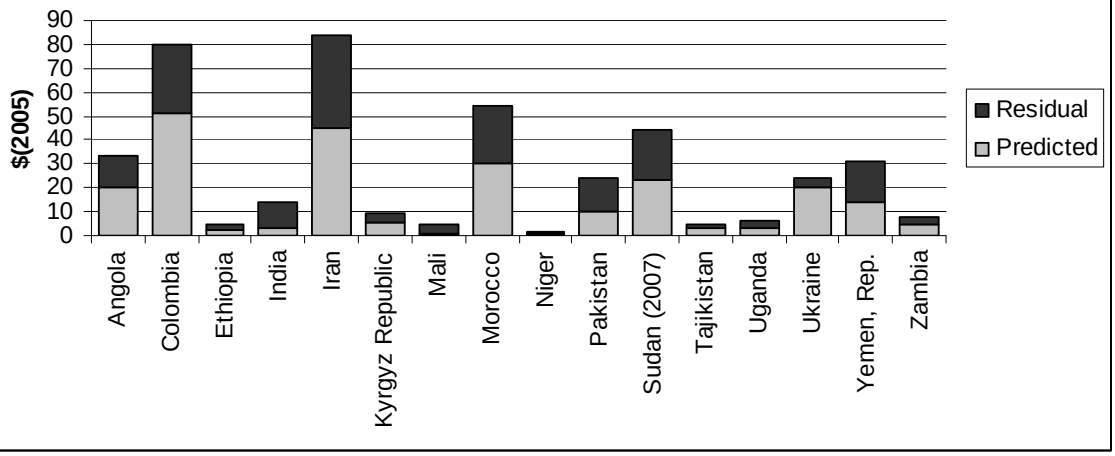
Figure 9: Military Expenditure per Soldier
Predicted and Residual, Fixed Effects Panel Regression



[31] In addition to the variables above, we control for the scale of the conflict (battledeaths), size of the peacekeeping force following end of civil wars, share of value of exports due to oil and minerals, and squared variables for population and area. None of these variables were significant determinants of military expenditure per soldier or per capita, and were therefore left out of the parsimonious models reported in appendix table 1. However, it is possible that some of these relatively time-invariant effects (such as the dummy variable for civil war) are accounted for by fixed-effects.

Each bar reflects total military expenditure per soldier in each country for 2005 (2007 in the case of Sudan), including the predicted element of this expenditure and the unpredicted element reflected by the residual. Colombia, Iran and Sudan clearly exhibit very high military expenditure per soldier. Additionally, approximately $8,000 per soldier for Sudan is unexplained by the model. Similarly, some of the expenditure for India, Iran, Mali and Zambia is unexplained by the model, suggesting that all of these countries spend more on the military than the model would predict. Likewise, military expenditure per capita is reflected in Figure 10.

Figure 10: Military Expenditure per Capita
Predicted and Residual, Fixed Effects Panel Regression



In Figure 10, Sudan has high levels of military expenditure per capita exceeded only by Colombia, Iran and Morocco and nearly half of this expenditure is unexplained by the model. Again, the comparator countries for both Figures 9 and 10 are those countries with positive residuals in all four models in Appendix Table 1, so this reflects high levels of unexpected military spending even among those countries with high residuals.

While the table and figures above demonstrates unsustainable and unpredicted levels of military expenditure by Juba and Khartoum, Table 3 below shows how this military expenditure has substantial opportunity costs in terms of development. Progress on most of the Millennium Development Goals is not likely to be "on track" even for the peaceful and relatively better off states in the North, much less in the South, where the ten Southern states are demonstrably lagging in progress in all indicators behind their counterparts in the North and the mean for Sub-Saharan Africa.

Table 3: Development Indicators, Sudan vis-à-vis Sub-Saharan Africa

	Sudan's Millennium Development Goals	Average of Northern States	Average of Southern States	Sudan National Average[1]	Sub-Saharan Africa
Net primary school attendance rate (%)	100 (by 2015)	67	17	47	69
Ratio of girls to boys attending primary education	1 (by 2005)	0.91	0.76	0.85	0.89
Measles immunization coverage (%)	[2]	73	43	61	64
Proportion of births attended by skilled personnel (%)	[3]	70	33	55	44
Contraceptive prevalence (%)	[2]	9	4	7	23
Proportion of population using effective malaria prevention measures (%)	[2]	32	22	28	N.A.
Use of improved drinking water (%)	77.5 (by 2015)	55	62	58	56
Use of improved sanitation facilities (%)		38	7	26	37

Source: Sudan Household Health Survey (2006), World Development Indicators (2007).

[1] Simple averages are used for all indicators. Averages reported in the Sudan Household Health Survey are weighted by state, however, reliable estimates of weighted state populations are not available for use in calculation here.
[2]. The goal is to halt by 2015 and begin to reverse the spread of HIV/AIDS and the prevalence of malaria and other major diseases.
[3]. The goal is to reduce 1990 maternal mortality by two thirds.

Of course, the development impact of a reallocation of funds from military spending to development initiatives would strongly depend upon improvements in Sudan's policies and institutions. Several studies have found a statistically significant positive relationship between government health spending and MDG health outcomes (such as, reduction of under-five mortality and maternal mortality ratio) for countries with good governance and institutions; on the other hand, the relationship appears not significant for poorly-governed countries.[32]

Sudan's current levels of governance do not offer much hope for improved development outcomes as a consequence of a reduction of military expenditures: the country scores 2.5 in the World Bank's Country Policy and Institutional Assessment (CPIA) index (ranging from a minimum of 1 to a maximum of 6) and 1 in the Political Risk Services Group's index of bureaucratic quality (ranging from a minimum of 1 to a maximum of 6). However, if the democratic political reforms envisioned above actually take place, it would be reasonable to expect a general improvement in governance standards.

For the following two scenarios, we assume improvements in quality of bureaucracy and institutions. We take an extremely conservative approach, assuming that 25% of total unexplained military expenditures of the average from the four models in Appendix Table 1 ($ 219 million) is used for public health expenditures. According to the World Development Indicators (2007) public health expenditure in Sudan is only 1.4% of GDP, whereas military expenditures are 3.7% of GDP. Shifting the $219 million from military expenditure would result in a 33.5% increase in public health expenditure.

[32] See, for example, World Bank (2004) and Rajkumar and Swaroop (2002).

The results of such shifts suggest the following improvements in health indicators and, while data on impact is sparse, the implication is that similar shifts away from military spending and into social development would have similar impacts:

1) If for example, the quality of the bureaucracy were to improve from 1 to 3.7, results from Rajkumar and Swaroop (2002) predict that a 10% increase in health expenditure could lead to a 4.5% reduction of under-five mortality. In our case, the hypothesized increase of 33.5% in public health expenditures would lead to a 15% decline in under-five mortality (from 89 deaths per 1000 live births to 76 (WDI, 2006)).

2) If the CPIA were to improve from 2.5 to 3.25, results in World Bank (2004) predict that a 10% increase in health expenditures could lead to a 6.95% decline in maternal mortality ratio. Thus, a 33.5% increase in public health expenditures could conceivably lead to a 23% reduction in maternal mortality ratio (from 450 deaths per 100,000 live births to 346.5, (WDI, 2005)).

These predictions are out of sample estimates and must be used with caution. Still, it is not unreasonable to assume that 25% of the unexplained military spending could be diverted to productive development activities and realize the improvements above. These numbers demonstrate how little movement is necessary by both actors to find a more productive peace and the very real opportunity cost in terms of human development foregone to ongoing, high levels of military expenditure.

5. Extensions: Changes to the Payoffs

While many of the parameters are given by the CPA, such as oil-revenue sharing arrangements and the nature of the referendum, not all of the payoffs are set in stone.

While both actors may have an incentive to invest in conflict technology to force a preferred equilibrium as shown above, it is also possible that the two actors (and other interested parties) might invest in infrastructure to affect the payoffs as well.

5.1 Enhancing Economic Interdependence and Complementarity between North and South

The economies and societies of the North and South are already linked through, among other things, the presence of large communities of Southern Sudanese in Northern Sudan; and, the presence of large nomadic Northern tribes in the South for extended time during summer in search for water and pasture. Moreover, the complementarities and interdependence between the two economies are manifest in the oil pipeline transporting oil produced in the south to ports on the Red Sea in the North; the networks of railroad, roads and river transport linking the two regions; and, the active trade between the two regions. Investments to further deepen and expand economic interdependence during the interim period prior to the 2011 referendum might all contribute to another parameter, called "C" which could contribute an additive effect to unity payoffs. This could be reflected by changes in the payoffs under Unity.

Khartoum	A+(R/2)+C
Juba	B+(R/2)+C

For positive values of C, the complementarities from cooperation result in gains from unity that are conceivably greater than what either actor could expect from a peaceful partition. If investments in these areas can actually contribute to higher payoffs for both actors, then both Khartoum and Juba must consider weighing the marginal benefits of military expenditures against the effects of benefits associated with unity.

Even in the event of a partition vote, large gains form economic cooperation[33] might motivate Khartoum not to respond militarily, because the payoff from economic cooperation might be higher than the net gains the military option:

$$A+C-M_{K>} A+ \delta R- \gamma M_J -M_K .$$

Moreover, to the extent that the benefits of cooperation are perceived to be very substantial by the SPLM to the extent of providing some concessions at the margin, the following possibilities might be considered.

5.2 A Cooperative Confederate Option

In the event that unity turns out to be difficult to attain, a confederation between North and South provide a middle of the road option that would underpin cooperation, while allowing the Southern Sudanese to retain full control on their oil and other resources of interest[34]. A confederate system would underpin deeper cooperation on all of the areas of complementarities discussed above, most notably on the oil sector, where the southern Sudan oil could continue to be exported through the existing pipeline in a context of a broader cooperation that could also allow the North to retain a marginal share of the oil revenues. In this case the payoffs from peaceful cooperation for both Khartoum (and Juba) could be high enough to discourage a military option (or a pure partition):

Khartoum: $(A+ \theta R) + C - M_K > A+ \delta R- \gamma M_J -M_{K,}$
Juba: $[B+ (1-\theta)R] + C - M_J > B+ R- M_{J,}$ where $\theta < \min\{1/2, \delta\}$

[33] The gains from cooperation may be smaller under partition; this is easily modeled by introducing a parameter less than 1 for scaling the effects of cooperation. This parameter is excluded from the analysis for simplicity.

[34] Admittedly this presents a constitutional challenge because it would require amending the CPA to allow for this option in the referendum. However, it might not be a far fetched option, since some leaders of the SPLM have recently floated the idea as a possibility that they might consider.

5.3 A Neutral Abyei Zone as an Investment in Peace

Under this arrangement, Abyei will be a neutral self-governing region, with full control of its oil and natural resources by its Dinka Nkong and the Messeriya inhabitants. Despite their inherent conflicts, among other things over water and grazing lands, these two communities have had a long history of cooperative relationship[35]. Moreover, given that, according to recent estimates, the Abyei oil reserves are not likely to be substantial, such arrangement would entail a relatively small compromise but high payoffs to both sides. It would not only put off a major potential flashpoint of conflict but it could influence the overall relationship between North and South. The groundwork for this solution may be being set in the Abyei Roadmap (see footnote 4).

5.4 The Potential Role of the International Community

The international community has an important role to play in this strategic interaction between Khartoum and Juba. By committing to support the outcome of the referendum, the international community could reduce Khartoum's prospective benefits from war (δR) while increasing its costs (γM_J), thus reducing the probability of the North's violent reaction in case the South opts for independence. Care must be taken, however, to ensure that offers of military support are carefully crafted to support the peace, as any offer that augments or supplements either actors military spending could effectively contribute to that actor's preference for war, overriding the preference for peace and possibly contributing to the arms race and preventive war by both parties. Even given security guarantees such as "Over the Horizon" guarantees of peace, it is also important

[35] For example, a recent ICG report observes that,consistent with the cooperative tradition between the two communities, "many Misseriya and Ngok Dinka leaders have been working at the local level to safeguard the peace and prevent a larger conflict. The SPLA/SAF Abyei Security Committee has been functioning well, and two local meetings between tribal leaders have taken place." (2008: p. 10).

that the international community recognize the need for some measure of democratization for a meaningful cooperation between Khartoum and Juba that should go beyond the NCP-SPLM to enfranchise the other popular political parties in the country. In this context the international community should support solutions like the recent initiative by opposition parties, led by the Umma Party, aimed at negotiating with the NCP to forge a national consensus on elections and transition to democracy in return for a "safety net" for the NCP should it lose the election and national commitment to the full implementation of the CPA on the part of the winners to assure the SPLM. Such extensions to the franchise that would increase political competition and break political duopoly inherent in the current situation is certainly more desirable than an election alliance between the NCP-SPLM conditional on full implementation of the CPA, as believed to have been proposed by the SPLM; or the alternative proposition of full implementation of the CPA conditional on an electoral alliance between the two as alleged to be the counter proposal from the NCP (ICG, 2008).

A more credible and positive intervention on the payoffs for Juba and Khartoum would entail a complete package that includes measures to promote deep democratic transformation in North and South, decreases in military dependence and investments in economic interdependence. The international community should help the achievement of a speedy and amicable resolution of the Darfur conflict; support a timely execution of a comprehensive and sound population census (scheduled for April 15-30, 2008), including by providing sufficient number of qualified international observers; and encourage the Sudanese political parties and civil societies to agree on an election law that meets international standards and to commit enough resources to ensure that the multi-levels

elections are timely, transparent and fair[36]. The international community should also support capacity and institutional building as well as investments in social service and economic growth, including projects for the promotion of economic complementarities and interdependence between North and South, such as Abyei. There is a growing consensus in the peace-building scholarship community that economic growth and credible public institutions are critical for both sustainable post conflict peace as well as for stable post-conflict democratization (e.g. Sambanis, 2008; Keefer, 2008).

6. Conclusion

The simple game-theoretical model presented in this paper highlights risks of renewed violence in Sudan following the 2011 referendum as well as opportunities for conflict-mitigating policy intervention. The South would opt for partition if it expects that the North will not respond with force. The North in turn would acquiesce to partition if it expects a difficult and costly war to stop the southern bid for independence. Both sides have an incentive to increase their military spending, thus diverting scarce resources away from badly needed development initiatives.

In a situation of imperfect information (as in the real world), there is risk of war by miscalculation, even if both sides prefer the status-quo over renewed violence: the South could choose partition in the mistaken belief that the North would acquiesce. In addition, each side's need to signal to the opponent military strength risks causing an "arms race" between the North and the South, which in turn could lead to a "security dilemma". In this scenario, each actor may see the other's efforts to arm as potentially aggressive and may be tempted to launch a preventive attack for fear of being attacked in

[36] According to the CPA, elections should take place at six levels: the Presidency of the Government of National Unity, he Presidency of the Government of Southern Sudan, the National assembly in Khartoum, the Southern Sudan Legislative assembly in Juba, 25 States Legislature, and 25 States Governors.

a moment of relative weakness. The international community, by promoting the completion of the CPA-mandated census and other technical issues related to the CPA-mandated general elections of 2009 as well as by urging more transparency on both sides' military expenditures can reduce information asymmetries and the risk of an arms race. In addition, the international community could decrease the risk of renewed violence by supporting a process of democratization of Sudanese politics (including the 2009 elections). Democratization is shown in the model to provide a useful commitment device and resolve some of the credibility issues that are currently contributing to excessive militarization by both sides and might result in unwanted and unintended conflict. Democratization is also likely to have much more significant impact beyond its positive influence associated with reduced military expenditure. A genuine democratic transformation might actually make unity attractive to Southern Sudanese; and even if the latter opted for partition, the two emerging democracies are likely to assign a higher value to economic interdependence and cooperation than any payoffs that might be reaped by conflicts and war. The opportunity cost of miliatarization and conflict in terms of human development suggest that all actors have an incentive to create commitments for a lasting and credible peace. Finally, the international community's promotion of investment in crucial sectors (e.g., oil) could play an important role in increasing economic complementarities between North and South, thus potentially reducing the probability of both partition and war.

Appendix Figure 1:

Appendix Table 1:

	Military Expenditures per Soldier, Fixed Effects Panel	Military Expenditure per Soldier, Pooled Panel	Military Expenditure per Capita, Fixed Effects Panel	Military Expenditure per Capita, Pooled Panel
GDP per Capita	4.219***	2.211***	.028***	.023***
	(1.11)	(0.45)	(0.01)	(.003)
Democracy	307.2*	28.51	2.96***	-.545**
	(158.9)	(39.78)	(1.07)	(0.27)
$Democracy^2$	-14.297*		-.142***	
	(7.53)		(0.51)	
Year	-166.4***	-170.9***	-.774***	
(after 1990)	(32.06)	(54.34)	(0.21)	
Area		0.001***		1.712e-06**
		(0.00006)		8.388e-07
ln(Population)				-1.59
				(1.20)
Landlocked				-6.72**
(dummy)				(3.31)
Constant	657.84	3044.48***	-6.24	34.86*
	(1139.2)	518.14	(7.69)	(21.05)
N (Observations)	1090 (91)	1090	1097 (91)	1097
R^2	.13	.14	.25	.27

Significance: *<5%, **<2%, *<1%.

GDP per capita, Population and Area (sq km) from the World Development Indicators (WDI, 2007). Here democracy is the composite polity score from the Polity IV index (Democracy-Autocracy+10). In addition to the variables above, we included control variables in earlier models accounting for scale of the conflict (battledeaths), size of the peacekeeping force (SIPRI peacekeeping data), share of value of exports due to oil and minerals (WDI), and squared variables for population and area. None of these latter variables were significant determinants of military expenditure per soldier or per capita, and were therefore left out of the parsimonious models reported above. For fixed effects regressions, the number of countries in the panel is included in parentheses.

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